



Patiently watching Jets giving Feedback

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Jets:

- * remove angular momentum from disks
- * clear cavities
- * transfer energy/momentum to surroundings

How relevant?

- * how much energy/momentum is provided?
- * how much energy/momentum is lost?

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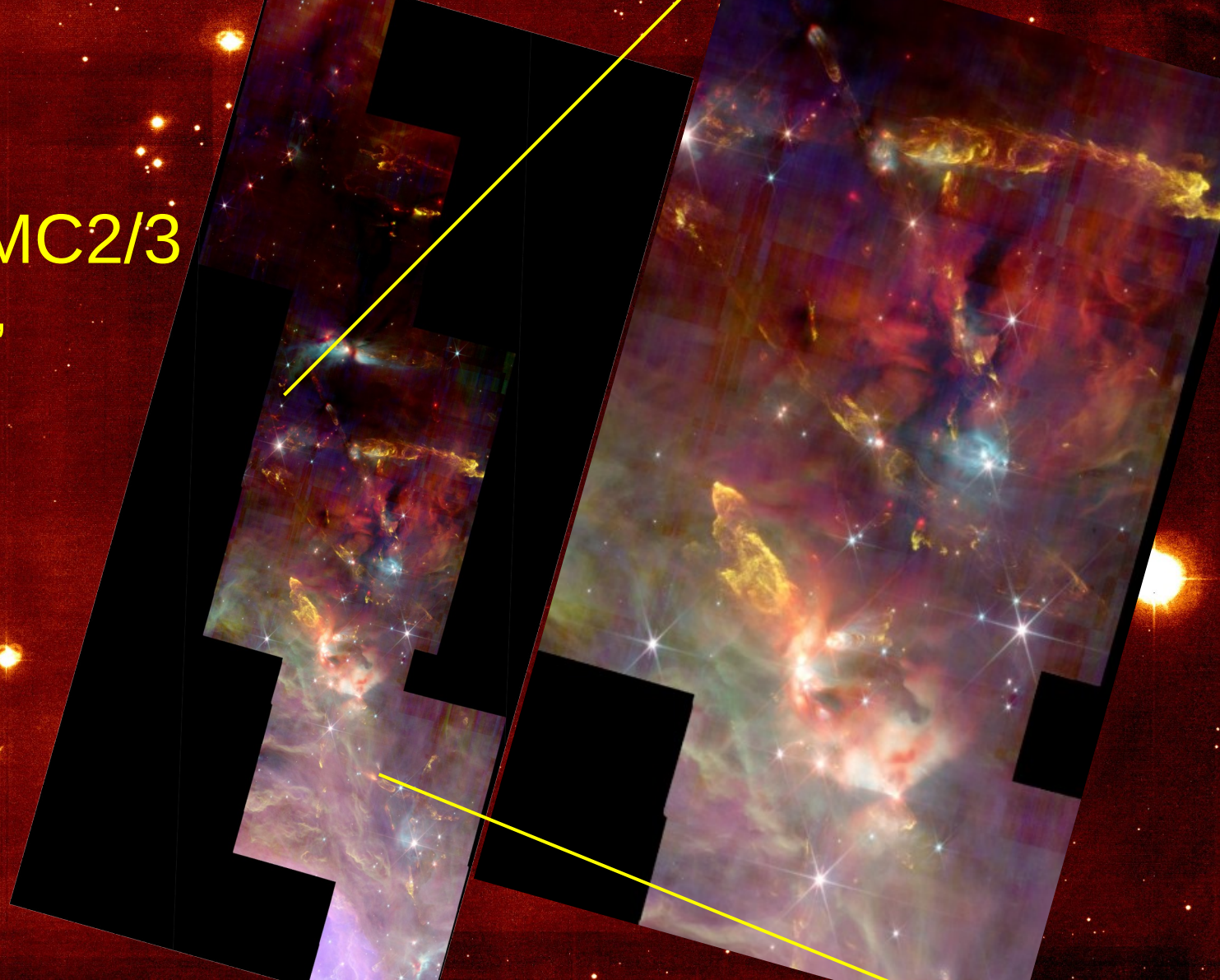
* Molecular outflows (CO)

compromise between spatial resolution, area, sensitivity
radial velocities only

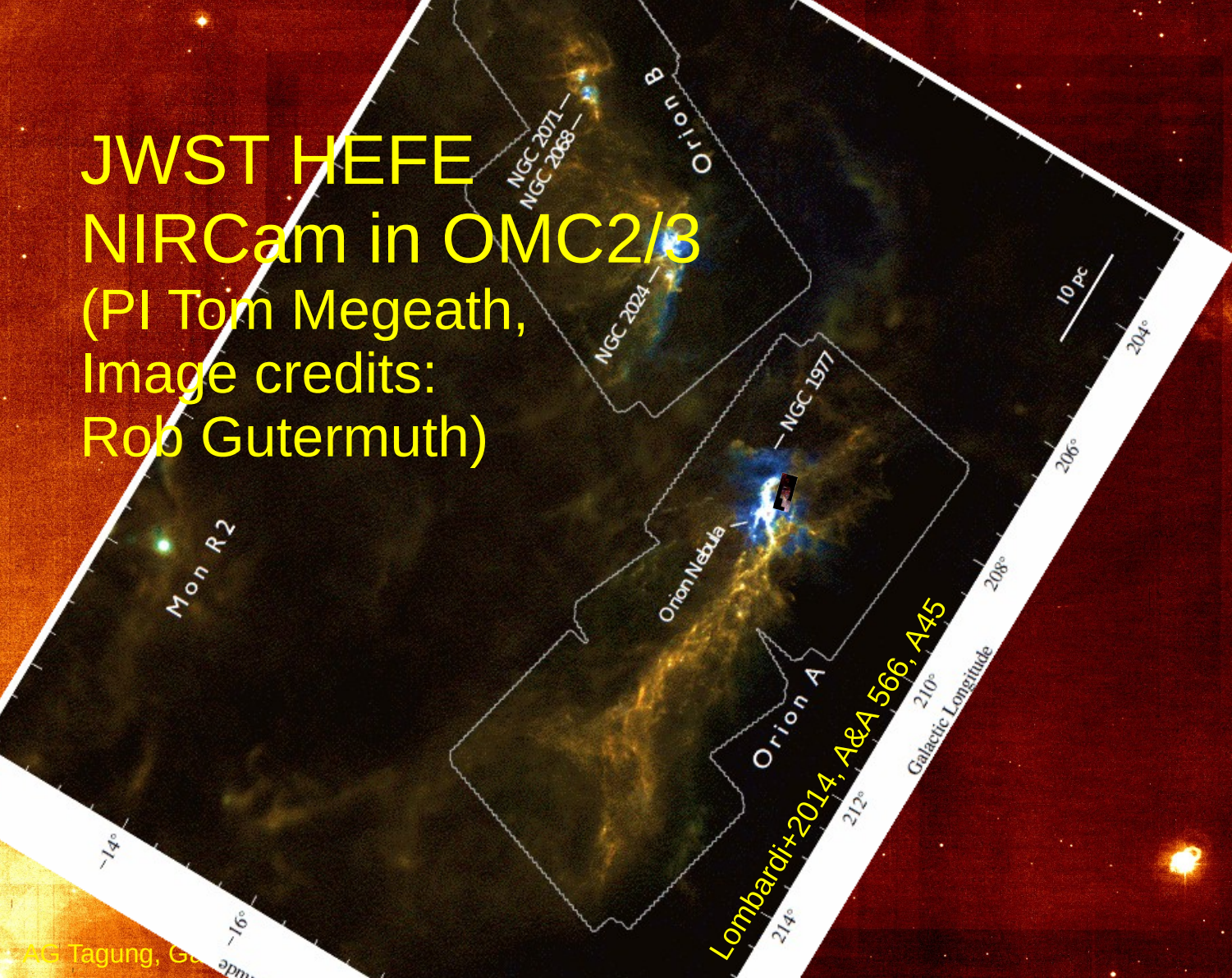
* optical/IR: shocks

proper motions (few 10 to few 100km/s), radial velocities
compromise between area coverage and resolution/timescale

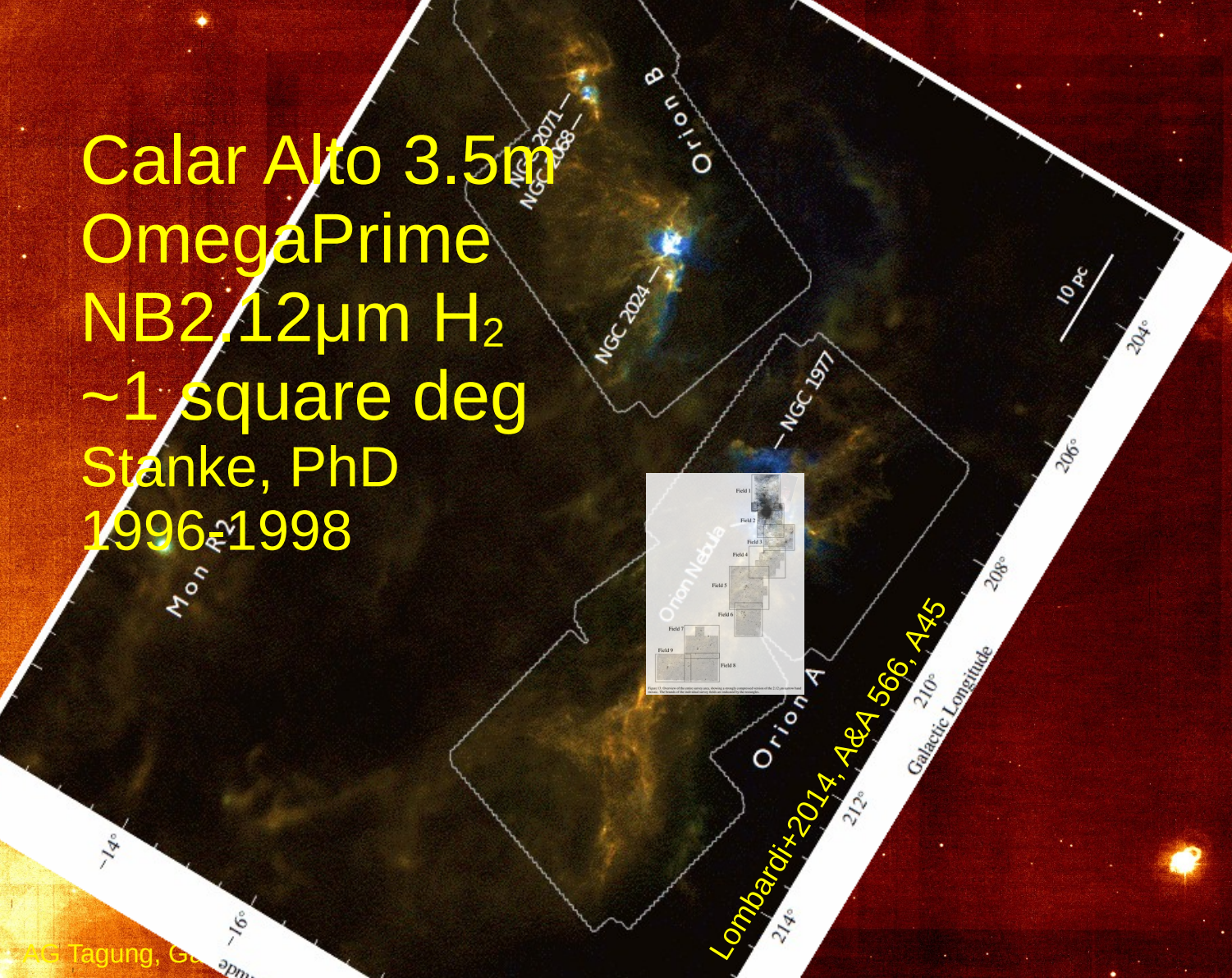
JWST HEFE
NIRCam in OMC2/3
(PI Tom Megeath,
Image credits:
Rob Gutermuth)



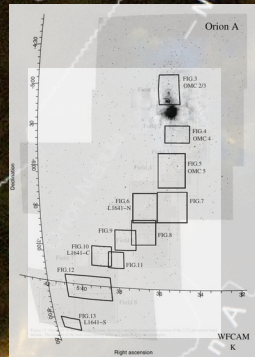
JWST HEFE
NIRCam in OMC2/3
(PI Tom Megeath,
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Calar Alto 3.5m
OmegaPrime
NB2.12 μ m H₂
~1 square deg
Stanke, PhD
1996-1998



UKIRT
WFCAM
NB2.12 μ m H₂
~8 square deg
Davis+2009,
A&A 496, 153
2005-2007



Lombardi+2014, A&A 566, A45

Calar Alto 3.5 OmegaPrime

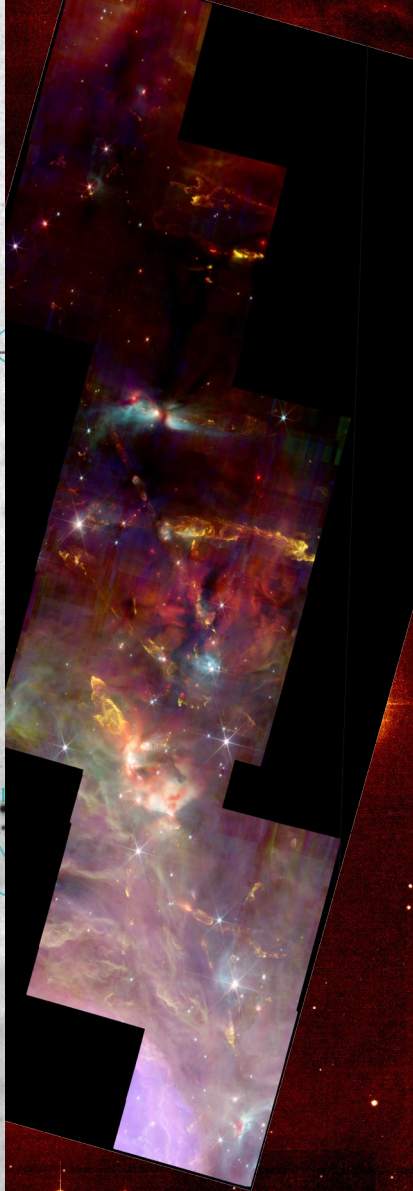
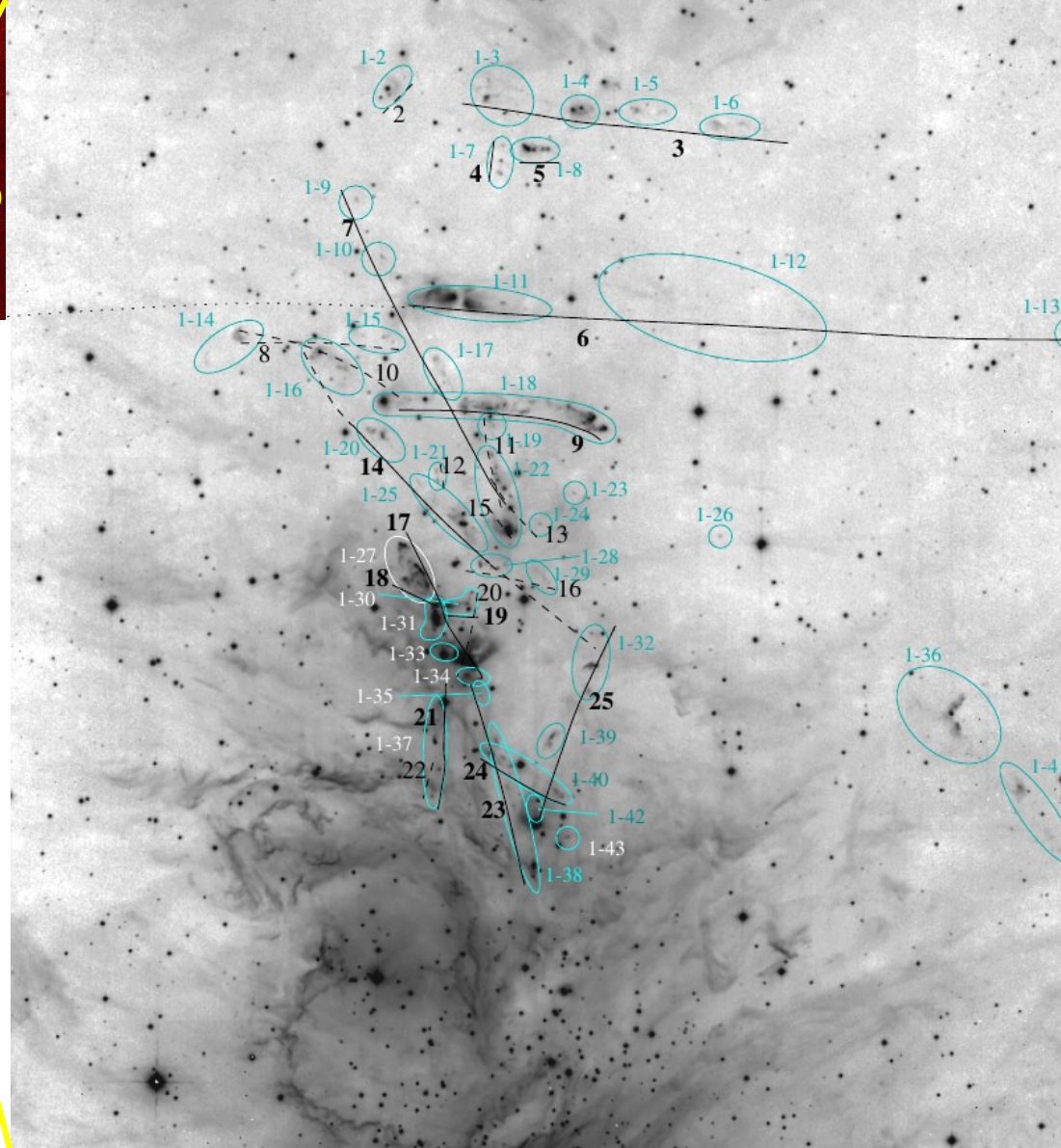
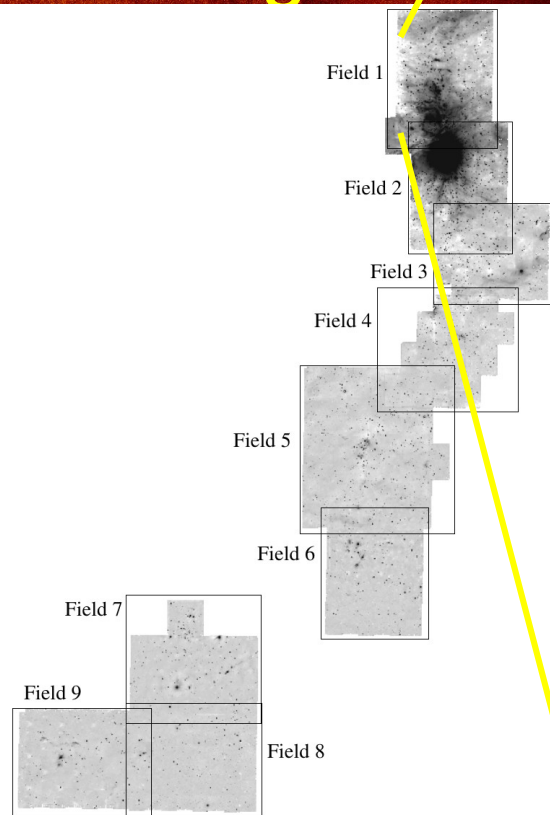
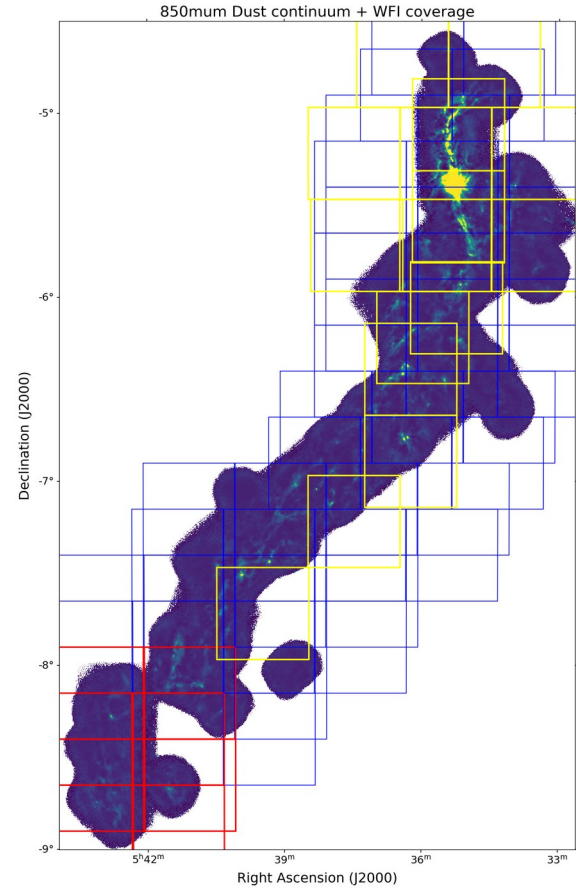


Figure 13: Overview of the entire survey area, showing a strongly compressed version of the $2.12\mu\text{m}$ narrow band mosaic. The bounds of the individual survey fields are indicated by the rectangles.

ESO/MPG 2.2m
WFI
NB Halpha, [SII]
~2 square deg
...
1999-2002 (yellow)



(ESO)/MPG 2.2m

WFI

NB Halpha, [SII]

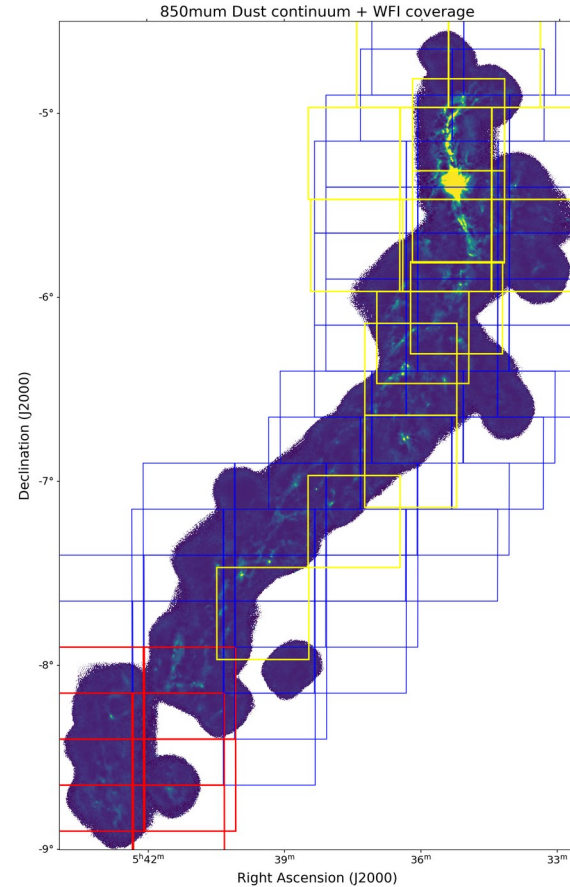
~5 square deg

...

1999-2002 (yellow)

2023-2024 (blue)

→ temporal baseline 20+ years!
(for the yellow parts...)



(ESO)/MPG 2.2m
WFI

NB Halpha, [SII]
~12 square deg

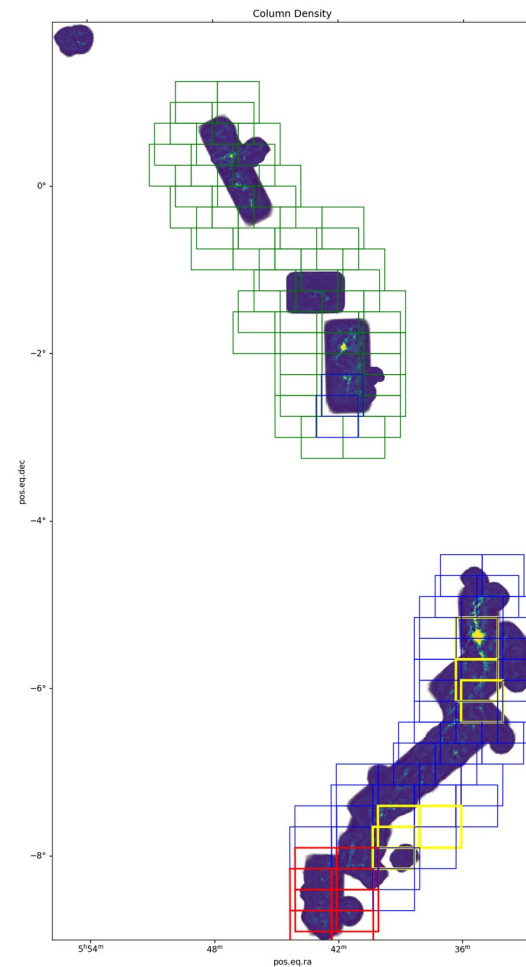
...

1999-2002 (yellow)

2023-2024 (blue)

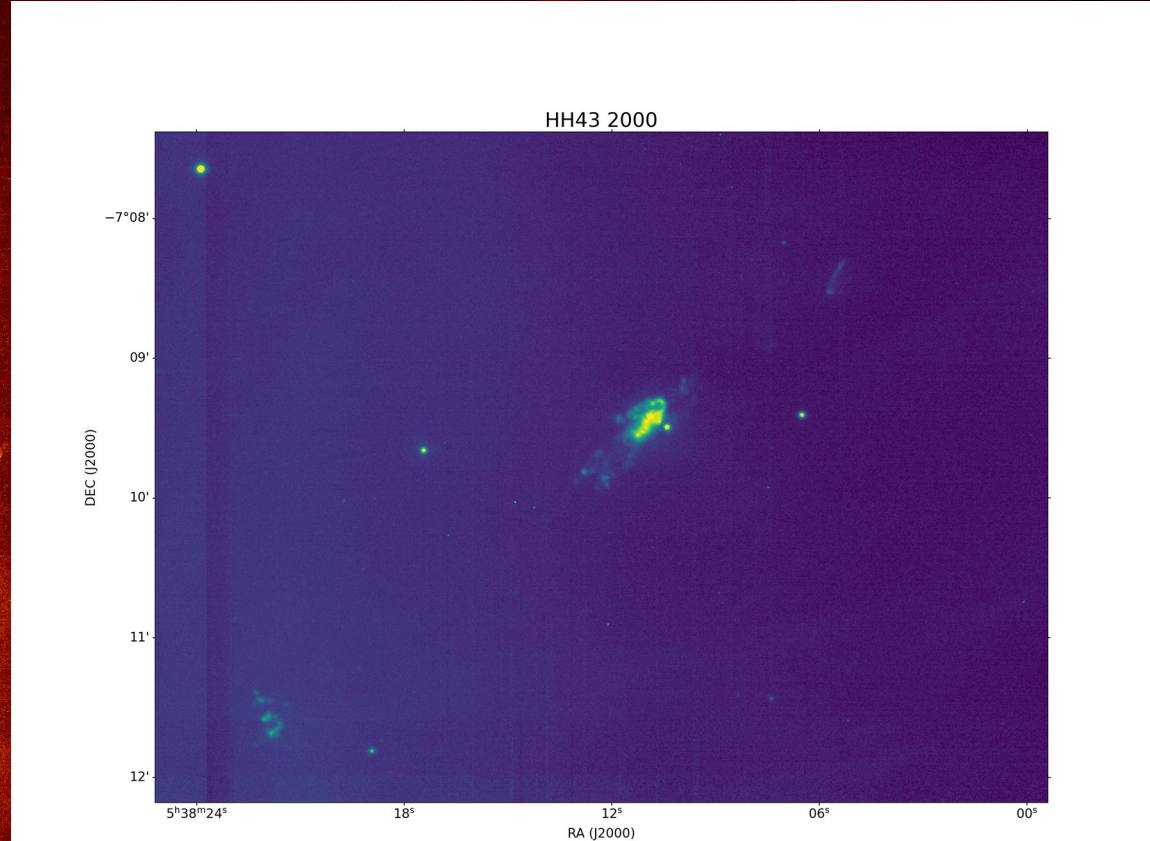
2025-202x (red)

→ full census of Herbig-Haro flows



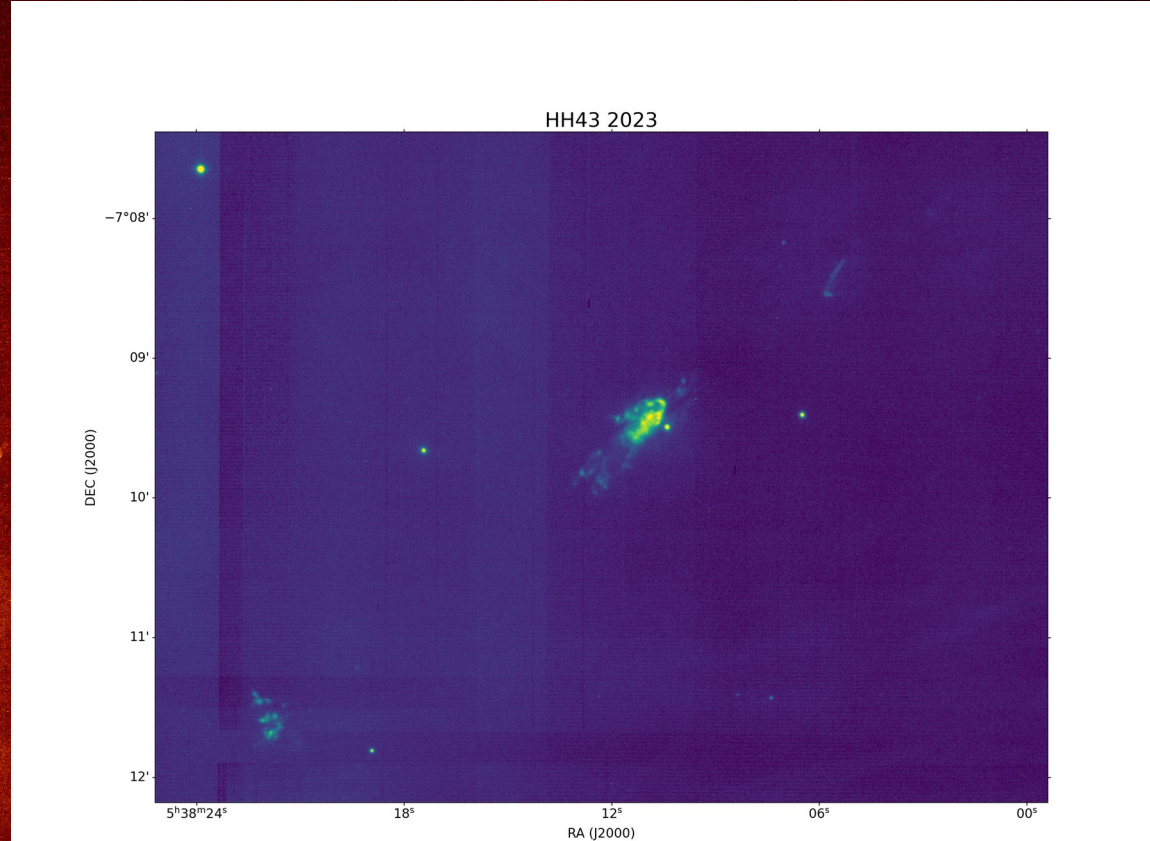
Proper motions:

- * identify “features”
- * pair them between epochs
- * determine shift



Proper motions:

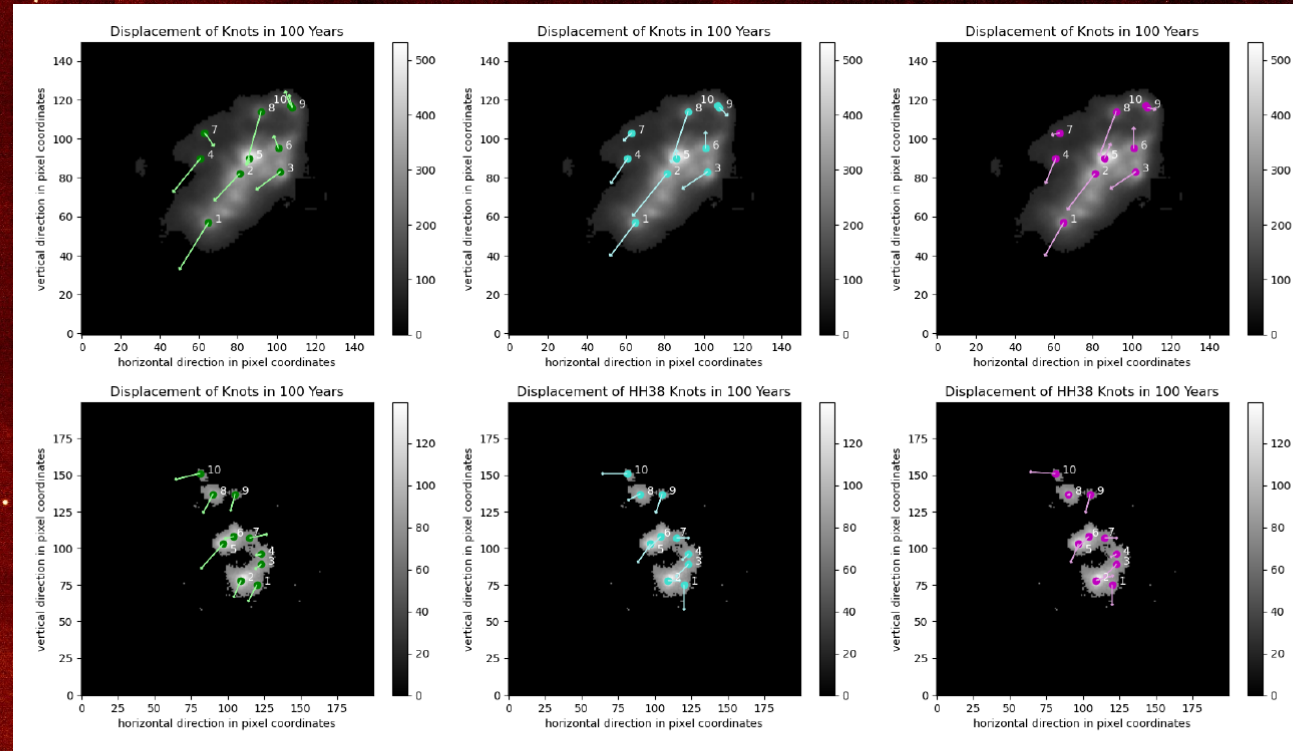
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Helen Hofer, BsC
(2024)

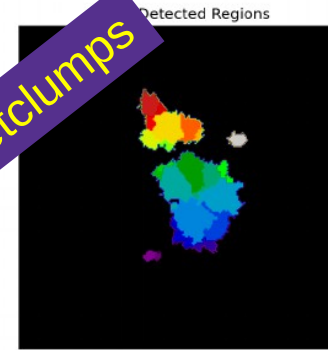


Proper motions:

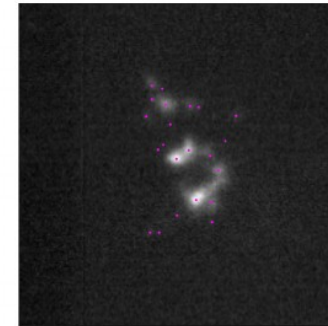
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- * *determine shift*

Filip Milicevic, BsC
(2025)

Facetclumps

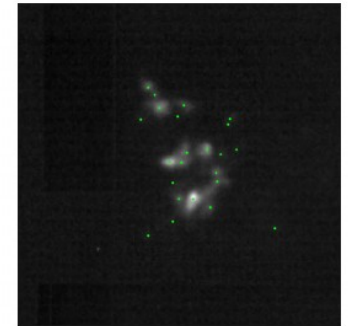


2000: Clump Centres (bright)

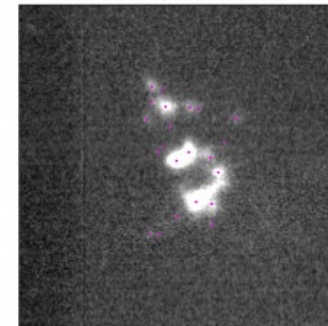


2023: Detected Regions

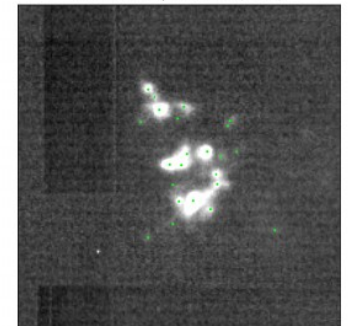
2023: Clump Centres (bright)



2000: Clump Centres (faint)



2023: Clump Centres (faint)

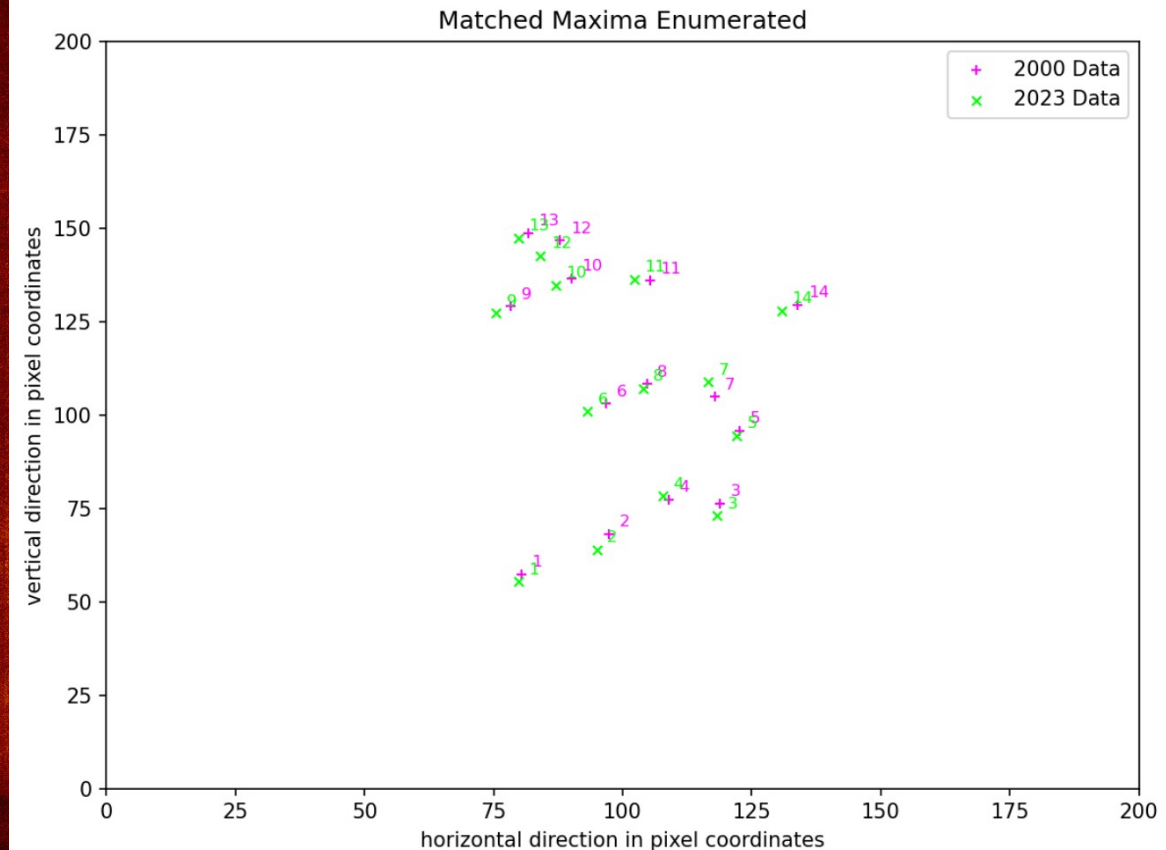
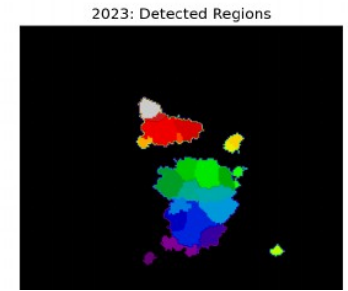
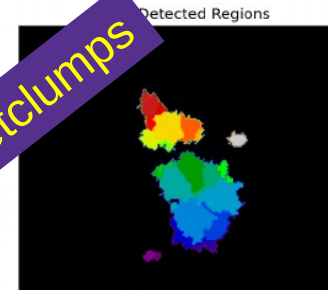


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Filip Milicevic, BsC
(2025)

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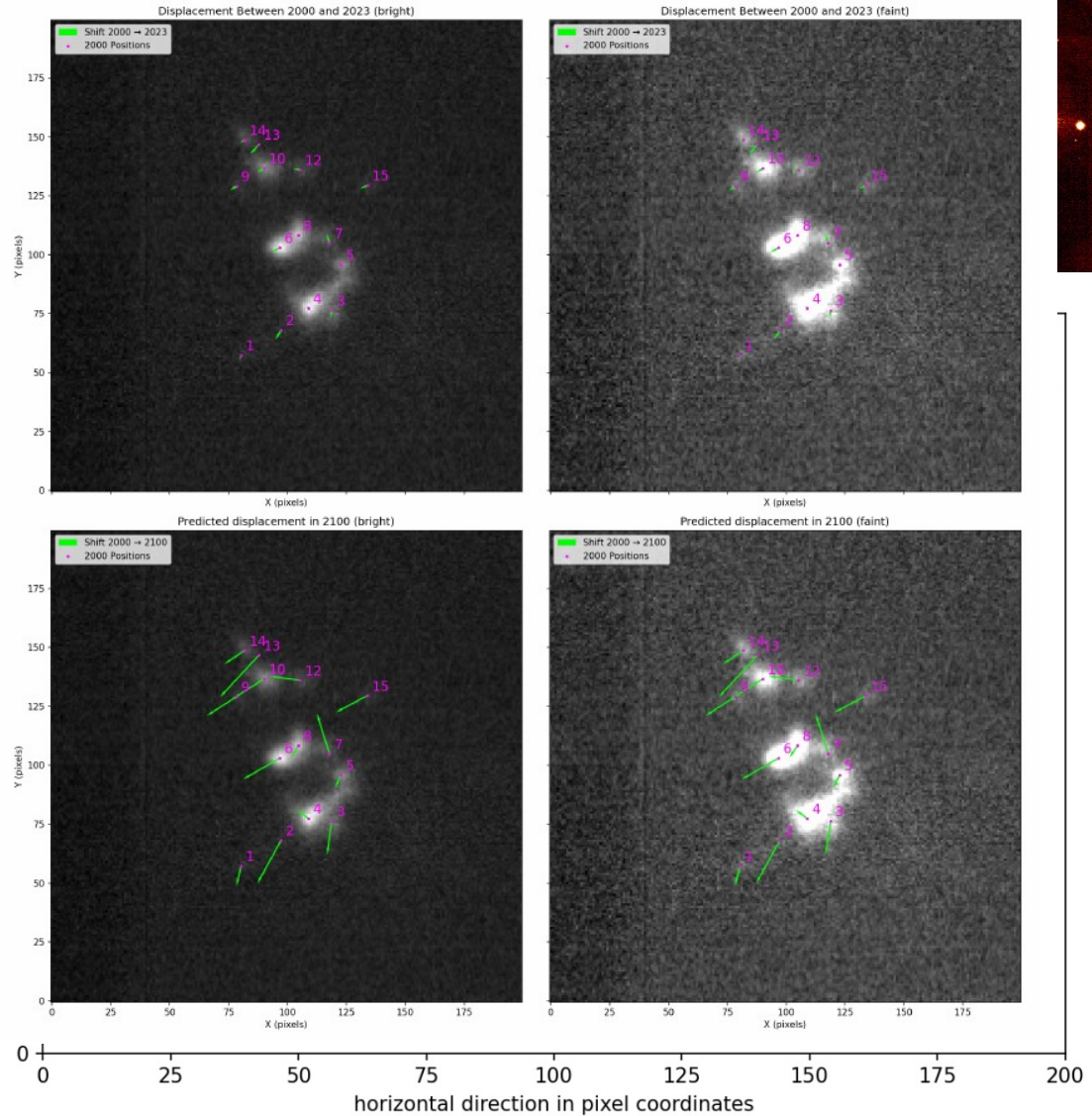


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Filip Milicevic, BsC
(2025)

vertical direction in pixel coordinates





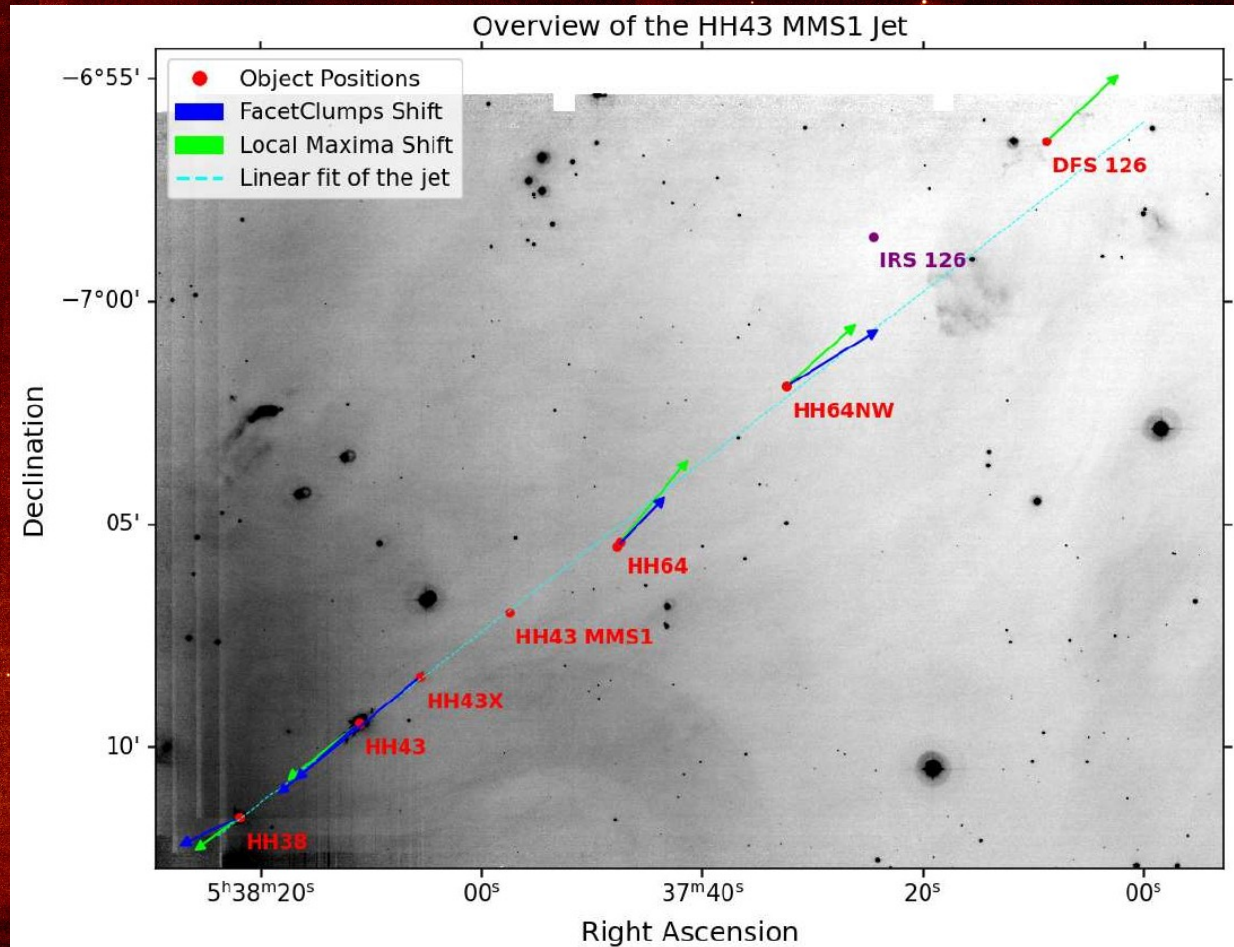
Proper motions:

The HH43 giant outflow

Proper motions:

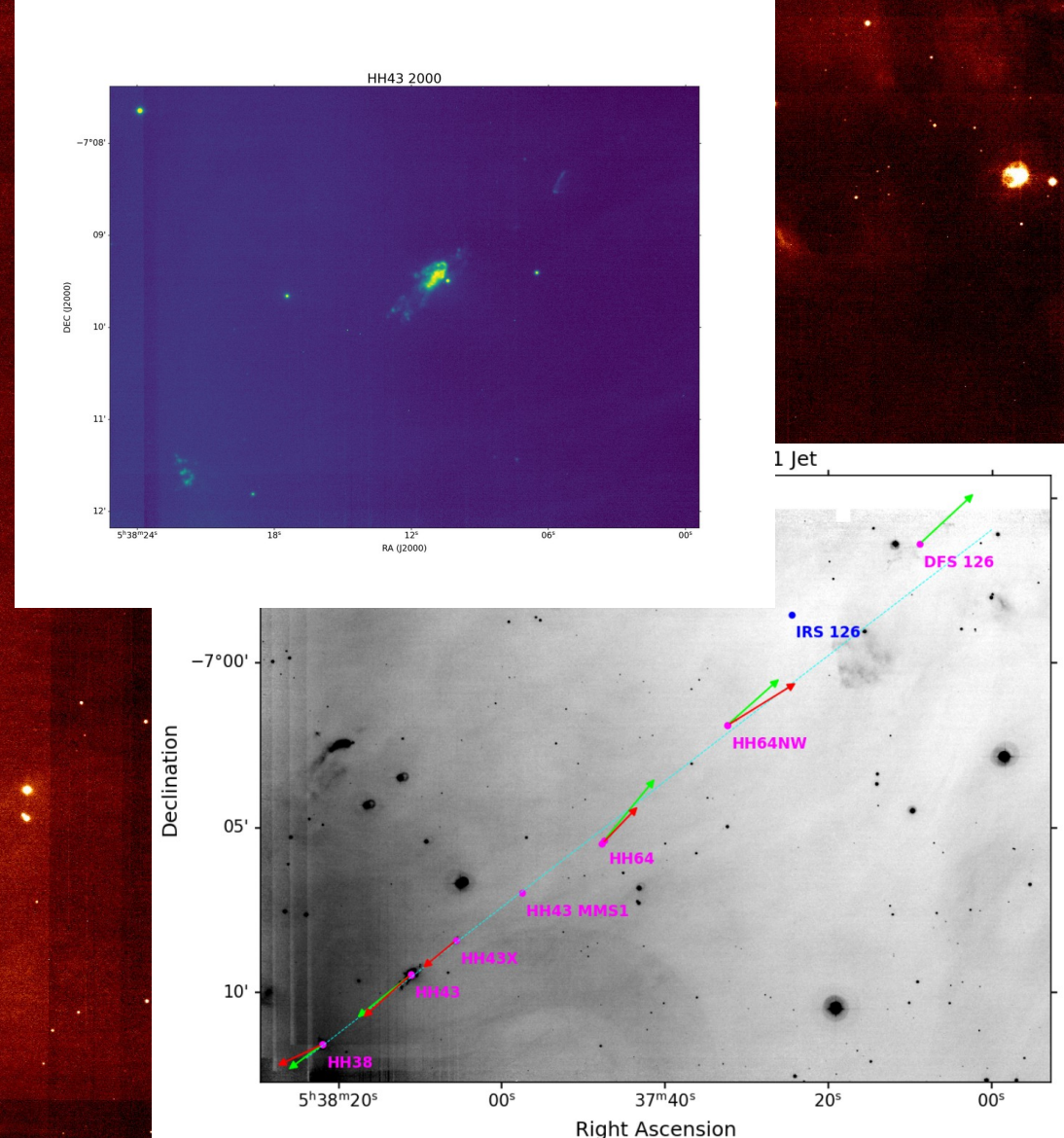
The HH43 giant outflow

Total length: ~ 3 pc
... decelerates in
the southern lobe



Summary:

- Cloud wide outflow surveys are needed and possible
- Using long separations between epochs and up-to-date analysis, proper motions for large-ish outflow samples can be measured
- HH43 is 3pc long and loses momentum in one lobe



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- Cloud wide outflow surveys are needed and possible
- Using long separations between epochs and up-to-date analysis, proper motions for large-ish outflow samples can be measured
- HH43 is 3pc long and loses momentum in one lobe
- 2nd (or 3rd) epoch approved on Calar Alto... 30yr later!

